REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited. (2)
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S): AFOSR-TR- 88-1694
6a. NAME OF PERFORMING ORGANIZATION: University of Arizona; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION: Air Force Office of Scientific Research
6c. ADDRESS (City, State, and ZIP Code): Department of Matheamtics, Building #89	7b. ADDRESS (City, State, and ZIP Code): Building 410, Bolling AFB, DC 20332-6448
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: AFOSR; 8b. OFFICE SYMBOL (If applicable): NM	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: AFOSR-84-0205
8c. ADDRESS (City, State, and ZIP Code): Building 410, Bolling AFB, DC 20332-6448	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 61102F; PROJECT NO. 2304; TASK NO. A5; WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)

Imperfect repair for multi-unit systems and description of life lengths by conditional failure rates.

12. PERSONAL AUTHOR(S)

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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
FINAL	FROM 1 Jun 84 TO 31 May 88		

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Results have been obtained on the influence of the working environment and of the current wear of the components on the failure rate of each component in a system. Results have also been obtained on the import on system relaibility of imperfect component repair. Studies have been completed on replacement and maintenance policies for multi-unit systems. → a page

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
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DD Form 1473, JUN 86 — Previous editions are obsolete. — SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED

Final Technical Report

Grant No.: AFOSR - 84 - 0205 AFOSR-TR- 89-1684

Title: Imperfect repair for multi-unit systems and description of life lengths by conditional failure rates

Expired: 31 May 1988

The proposal for Grant AFOSR - 84 - 0205 consisted of the following parts:

(1) Study of the causes for dependency of random lifetimes,

(2) Study of imperfect repair of multi-unit systems, and

(3) Study of various other replacement and maintenance policies for multi-unit systems.

We have achieved most of the objectives of the proposal as is described below.

(1) The failure rate of a component of a multi-unit systems depends on various factors. We have looked specifically on the influence of the working environment and of the current wear of the components on the failure rate of each component. The results of our studies are described in [1]. In particular, we have found conditions on the fashion of dependence which imply that the lifetimes of one system are larger than the lifetimes of another system. Also, positive dependence properties, of lifetimes of different compoents of a system, were established in [1].

(2) Often when a component of a system failed it is not scrapped, but instead it undergoes a repair. The repair may be successful and then it brings the item to its state just before failure. The repair may be unsuccessful and then the item is scrapped and replaced. When this is the situation then we say that the component is imperfectly repaired. Under the covered grant we studied various properties of systems with several units, each of which undergoes an imperfect repair upon failure. Upon failure, the probability of a successful repair may depend on several factors. We have considered the situation in which this probability depends on the working environment and on the wear of the components of the system. We have established various properties of such systems. For example, in [2] we have found the relationship between imperfect repair and the multivariate IFRA (increasing failure rate average) property of the joint lifetimes of the components of the system.

(3) Consider a collection of components which function at a random environment. The failure rate of a component at time t, say, may depend then on the state of the environment at that time and on its age. Suppose that a failed item is replaced by a new one upon failure. Various

replacement and maintenance policies can be used in such a situation in order to assure high reliability of the components. For example, block replacement of all the components may be performed at scheduled intervals. Minimal repair of failed components may be sometimes preferable to a replacement. Combinations of various maintenance and replacement policies have been studied in [3]. We have mathematically compared various such policies and in many cases we have shown that some policies are overall better than others.

Some work that has not been described in the proposal, has been done under this grant. In [4] we characterized some mathematical stochastic orderings of multivariate distributions by means of intuitive notions from reliability theory. In [5] we described a dynamic construction for simulation of random vectors using some intuitive notions from reliability theory. And in [6] we have obtained some stochastic convexity and concavity properties of stochastic processes which have applications in reliability theory as well as in queueing theory.

References

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